**Medical Informatics: Epidemiology**

1. **Basic statistical terms in epidemiology (incidence/prevalence/mortality/lethality of disease)**

Incidence is the number of instances of illness commencing, during a given period in a specified population. The number of new health-related events in a defined population within a specified period of time.

Prevalence is the proportion of population who have specific characteristic in given time. It is disease occurrence or other factor related to health, the total number of individuals who have the condition at a particular time divided by the population at risk of having the condition at that time or midway through the period.

Mortality is the number of deaths in a specific time or place, the proportion of deaths in a population and the rate of loss.

Lethality of disease is a description of how a disease can cause death and harm. [1]

1. **Output of diagnostic test**

A diagnostic test is a procedure performed to confirm, or determine the presence of disease in an individual suspected of having the disease, usually after symptoms are presented or reported or as a precautionary measure after results from another test are positive and there’s a chance the patient has another disease too. Some examples of diagnostic tests include X-rays, biopsies, pregnancy tests, medical histories, and results from physical examinations.

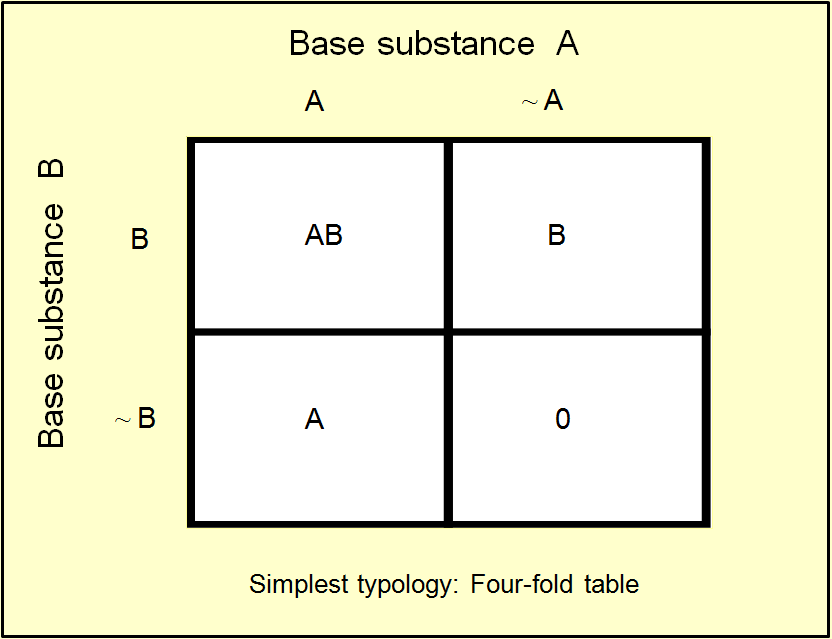
As discussed later in this presentation there are many mathematical methods that alter the probability and chance of an outcome before and after the test has occurred, but at the end of the day the end result of the test (the diagnosis) should be straight forward. A positive test should indicate the patient has the disease, or a negative indicates they do not. However, these simple results are not the only possibilities. They are however the logical ‘true’ results as they correctly relay the result. In fact, there are two more possibilities: the fact there is always a possibility for errors or incorrect readings to occur means that a person who might not have a given disease might test positive for it, or someone who has the disease may test negative for it. These incorrect possibilities are called ‘False’ results.

* *True positive*: the patient has the disease and the test is positive.
* *False positive*: the patient does not have the disease but the test is positive.
* *True negative*: the patient does not have the disease and the test is negative
* *False negative*: the patient has the disease but the test is negative.

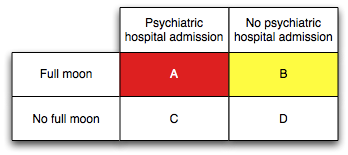
**3) Fourfold table (definition, example, construct)**

- **Definition:** Individual members of the sample/population are assigned to the appropriate cell of the contingency table according to their values for the two variables. When the table has only two rows or two columns this is equivalent to the comparison of proportions. In this case it is called four-fold table. [2]

- **How to construct fourfold table:**

[](https://www.google.cz/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=0ahUKEwjrhOyNgsTQAhVC2ywKHQnfCP0QjRwIBw&url=http://www.swemorph.com/it-art.html&psig=AFQjCNHqjHlwaDyrqAzieyeM0VGhO8BN7g&ust=1480166988642570)

- **Example:** **The Great Fourfold Table of Life**

Many scenarios in everyday life can be arranged in a fourfold table like the one here. For example, let’s investigate the question whether full moons are associated with more admissions to psychiatric hospitals, as emergency room physicians and nurses commonly claim.

To answer this question, we need to examine all four cells of the Great Fourfold Table of Life:

* Cell A which consists of instances when there’s a full moon and a psychiatric hospital admission.
* Cell B which consists of instances when there’s a full moon but no psychiatric hospital admission.
* Cell C which consists of instances when there’s a psychiatric hospital admission without no full moon.
* Cell D which consists of instances when there’s no full moon and no psychiatric hospital admission. [3]

**4. What is specificity and sensitivity of a diagnostic test? How can sensitivity and specificity be calculated from the fourfold table?**

**Sensitivity** and **specificity** are statistical measures of the performance of a binary classification test, also known in statistics as classification test:

* **Sensitivity** (also called the **true positive rate**, the **recall**, or **probability of detection** in some fields) measures the proportion of positives that are correctly identified as such (e.g., the percentage of sick people who are correctly identified as having the condition).
* **Specificity** (also called the **true negative rate**) measures the proportion of negatives that are correctly identified as such (e.g., the percentage of healthy people who are correctly identified as not having the condition).

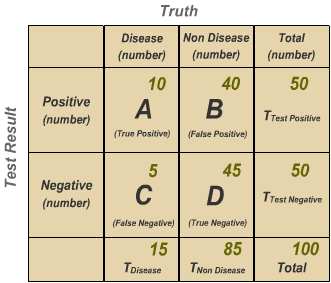
Sensitivity therefore quantifies the avoiding of false negatives, and specificity does the same for false positives.

Formula

Formula

[[4]](http://ceaccp.oxfordjournals.org/content/8/6/221.full)

100 people are tested for disease. 15 people have the disease;  85 people are not diseased.  So,  prevalence is 15%:

* Prevalence of Disease:   
  Tdisease/ Total **×** 100,   
  15/100 **×** 100 = 15% 

Sensitivity is two-thirds, so the test is able to detect two-thirds of the people with disease. The test misses one-third of the people who have disease.

* Sensitivity:   
  A/(A + C) **×** 100  
  10/15 **×** 100 = 67%

The test has 53% specificity. In other words, 45 persons out of 85 persons with negative results are truly negative and 40 individuals test positive for a disease which they do not have.

* Specificity:   
  D/(D + B) **×** 100  
  45/85 **×** 100 = 53% [5]

**5) ROC curve (definition and example)**

- Receiver Operating Characteristic (ROC curve) is a graphical plot that illustrates the performance of a binary classifier system

- The curve is created by plotting the true positive rate (TPR) against the false positive rate (FPR) at various threshold settings.

+) The true-positive rate (sensitivity): recall or probability of detection in machine learning.

+) The false-positive rate (fall-out or probability of false alarm): be calculated as (1 − specificity).

- The ROC curve is thus the sensitivity as a function of fall-out.

- ROC has been used in medicine, radiology, biometrics, and other areas for many decades and is increasingly used in machine learning and data mining research.

- The ROC is also known as a relative operating characteristic curve, because it is a comparison of two operating characteristics (TPR and FPR) as the criterion changes

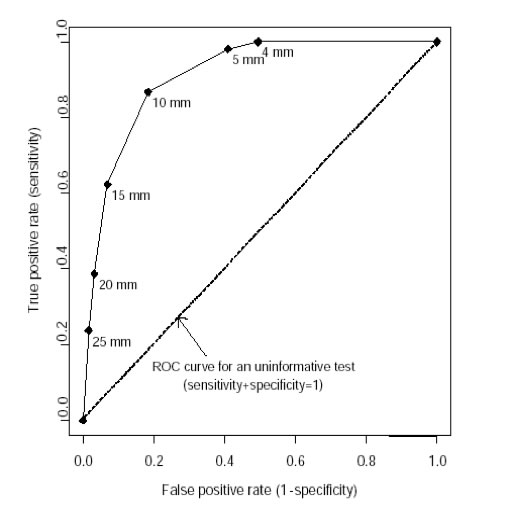
- A classification model (classifier or diagnosis) is a mapping of instances between certain classes.

**Endometrial ultrasound example**

Ultrasound can be used to detect thickening in the lining of the uterus, which may be an early sign of cancer. If abnormal, a biopsy or minor surgical procedure (dilatation and curettage or D&C) is needed. This is painful and invasive, and has some risk. So our goal is to maximize the number of true positives (correctly diagnosed cancers) with an acceptable number of false positives (false alarms requiring a biopsy).



|  |  |  |  |
| --- | --- | --- | --- |
| **Cutoff for abnormal wall thickness** | **Sensitivity (%)** | **Specificity (%)** | **1 - Specificity  (%)** |
| > 4 mm | 99 | 50 | 50 |
| > 5 mm | 97 | 61 | 39 |
| > 10 mm | 83 | 80 | 20 |
| > 15 mm | 60 | 90 | 10 |
| > 20 mm | 40 | 95 | 5 |
| > 25 mm | 20 | 98 | 2 |



Let's graph this in an ROC curve:

[6]

**6. Considering a screening and confirmation tests in medicine, when do we need to use high sensitive and when high specific test?**

In the screening test, the initial screening test have to be very sensitive. If anybody gets a positive results on that first screening test, we have to give them a second test which is the confirmatory test. This one would be very specific. The diagnostic of any diseases need to have both test positive. If we look at just either one, we will get high false positives or false negatives. But together both tests have relatively low probability false positive and false negative.

The high sensitive and high specific test are very important. For instance, in the case of screening donated blood from a blood bank for Bloodborne pathogens. Because the drawbacks of a false-negative are way higher than the drawbacks of a false positive. You may infect anybody easily so it has to be very sensitive. Alternatively, a disease that doesn’t have mortality or morbidity. There is a treatment for it but that treatment has a serious side effects that happen. In that case you have to be very specific with your diagnosis because the drawback of giving somebody a false positive and treating them with the potentially serious side effect of the drug would be a big drawback to consider.

[5] [7]

**References**

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